

Application No. 10/063,494
Docket No. 13DV-13485
Amendment dated March 5, 2004
Reply to Office Action of December 5, 2003

Amendments to the Claims:

This listing of claims will replace all prior versions, and listings, of claims in the application.

Listing of Claims:

Claim 1 (currently amended): A method of operating an electron beam physical vapor deposition coating apparatus, the method comprising the steps of:

performing a first coating operation during which:

at least a first article is placed in a coating chamber in which a gas-containing atmosphere is contained, the gas-containing atmosphere being at a first temperature and at a subatmospheric pressure; ~~a subatmospheric pressure is maintained;~~ and

an electron beam gun is operated to project an electron beam into the coating chamber and onto a ceramic material, the electron beam heating, melting and evaporating the ceramic material to deposit a ceramic coating on the first article;

wherein combined heat transfer ~~from the coating chamber and the ceramic material~~ to the first article from sources other than the gas-containing atmosphere within the coating chamber occurs at a first heat transfer rate while the first article is within the coating chamber, so that a surface temperature of the first article

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does not exceed about 1000°C during deposition of the ceramic coating on the first article; and

subsequently performing a second coating operation during which:

at least a second article is placed in the coating chamber while the gas-containing atmosphere within the coating chamber is at a subatmospheric pressure and at a second temperature that is higher than the first temperature; in which a subatmospheric pressure is maintained; and

the electron beam gun is operated to project the electron beam into the coating chamber and onto the ceramic material to heat, melt and evaporate the ceramic material and deposit a ceramic coating on the second article;

wherein combined heat transfer ~~from the coating chamber and the ceramic material~~ to the second article from sources other than the gas-containing atmosphere within the coating chamber occurs at a second heat transfer rate that is lower than the first heat transfer rate while the second article is within the coating chamber, so that a surface temperature of the second article does not exceed about 1000°C during deposition of the ceramic coating on the second article.

Claim 2 (original): A method according to claim 1, further comprising the step of preheating the first and second articles prior to being placed in the coating chamber.

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Claim 3 (original): A method according to claim 2, wherein the first and second articles are preheated to a temperature higher than 1000°C.

Claim 4 (original): A method according to claim 2, wherein the first and second articles are preheated to a temperature of about 1100°C.

Claim 5 (original): A method according to claim 1, wherein the first and second heat transfer rates are achieved at least in part by operating the electron beam gun at a higher power during the first coating operation than during the second coating operation.

Claim 6 (original): A method according to claim 1, wherein the first and second heat transfer rates are achieved at least in part by operating the electron beam gun to project the electron beam onto a larger surface area during the first coating operation than during the second coating operation.

Claim 7 (original): A method according to claim 1, wherein the first and second heat transfer rates are achieved at least in part by operating a heat-generating means within the coating chamber during the first coating operation, and reducing the heat output of the heat-generating means during the second coating operation.

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Claim 8 (original): A method according to claim 1, wherein the first and second heat transfer rates are achieved at least in part by positioning at least one heat-reflecting means a first distance from the first article during the first coating operation, and repositioning the heat-reflecting means to be a second distance from the second article during the second coating operation, the second distance being greater than the first distance.

Claim 9 (original): A method according to claim 1, wherein the first and second heat transfer rates are achieved at least in part by at least one heat-reflecting means located in the coating chamber and means for cooling the heat-reflecting means, the cooling means maintaining the heat-reflecting means at a first reflection temperature during the first coating operation and at a second reflection temperature during the second coating operation, the first reflection temperature being higher than the second reflection temperature.

Claim 10 (original): A method according to claim 1, wherein the first and second surface temperatures of the first and second articles are between about 925°C and about 1000°C.

Claim 11 (original): A method according to claim 1, wherein the coating

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material is yttria-stabilized zirconia.

Claim 12 (original): A method according to claim 1, wherein the coating material is zirconia stabilized by about seven weight percent yttria.

Claim 13 (original): A method according to claim 1, wherein the first and second articles are gas turbine engine components.

Claim 14 (currently amended): A method of operating an electron beam physical vapor deposition coating apparatus, the method comprising a plurality of successive coating operations by which thermal barrier coatings are deposited on gas turbine engine components during each of the coating operations, each of the coating operations comprising the steps of:

preheating the components to a preheat temperature;

placing the components in a coating chamber in which a gas-containing atmosphere is contained, the gas-containing atmosphere being at an elevated temperature and at a subatmospheric pressure; ~~a subatmospheric pressure is maintained;~~ and

operating an electron beam gun to project an electron beam into the coating chamber and onto at least one ingot of yttria-stabilized zirconia, the electron beam

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heating, melting and evaporating the ingot to deposit the thermal barrier coatings on the components;

wherein the electron beam is operated so that a molten pool of yttria-stabilized zirconia is continuously maintained during the successive coating operations and the temperatures of the ingot and the gas-containing atmosphere of the coating chamber continuously rise during the successive coating operations;

wherein combined heat transfer ~~from the coating chamber and the ingot~~ to the components from radiant sources other than the gas-containing atmosphere of the coating chamber occurs at a first heat transfer rate during a first of the coating operations, so that surface temperatures of the components are between about 925°C and about 1000°C during deposition of the thermal barrier coatings on the components during the first coating operation; and

wherein combined heat transfer ~~from the coating chamber and the ingot~~ to the components from radiant sources other than the gas-containing atmosphere of the coating chamber occurs at a second heat transfer rate that is lower than the first heat transfer rate during a last of the coating operations, so that surface temperatures of the components are between about 925°C and about 1000°C during deposition of the thermal barrier coatings on the components during the last coating operation.

Claim 15 (original): A method according to claim 14, wherein the preheat

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temperatures during the first and last coating operations are higher than 1000°C.

Claim 16 (original): A method according to claim 14, wherein the first and second heat transfer rates are achieved at least in part by operating the electron beam gun at a higher power during the first coating operation than during the last coating operation.

Claim 17 (original): A method according to claim 14, wherein the first and second heat transfer rates are achieved at least in part by operating the electron beam gun to project the electron beam over a larger surface area of the ingot during the first coating operation than during the last coating operation.

Claim 18 (original): A method according to claim 14, wherein the first and second heat transfer rates are achieved at least in part by operating a heat-generating means within the coating chamber during the first coating operation, and reducing the heat output of the heat-generating means during the last coating operation.

Claim 19 (original): A method according to claim 14, wherein the first and second heat transfer rates are achieved at least in part by positioning at least one heat-reflecting means a first distance from the components during the first coating operation,

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and repositioning the heat-reflecting means to be a second distance from the components during the last coating operation, the second distance being greater than the first distance.

Claim 20 (original): A method according to claim 14, wherein the first and second heat transfer rates are achieved at least in part by at least one heat-reflecting means located in the coating chamber and means for cooling the heat-reflecting means, the cooling means maintaining the heat-reflecting means at a first reflection temperature during the first coating operation and at a second reflection temperature during the last coating operation, the first reflection temperature being higher than the second reflection temperature.